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Neovascularisation and Recurrence 2 Years After Varicose Vein Treatment for Sapheno-Femoral and Great Saphenous Vein Reflux: A Comparison of Surgery and Endovenous Laser Ablation

N.S. Theivacumar, R. Darwood, M.J. Gough*

The Leeds Vascular Institute, General Infirmary at Leeds, Great George Street, Leeds LS1 3EX, UK

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Abstract *Objective:* Neovascularisation is a major cause of recurrent varicosities following surgery. This prospective cohort study compares recurrence rates and the occurrence of neovascularisation following surgery or endovenous laser ablation (EVLA) for great saphenous vein reflux.
Method: 118 consecutive patients (72 female, 46 male, median age 48 [range 32–68 years]), 129 limbs were reviewed at a median of 24 months (range 18–30) after surgery ($n = 60$ limbs) or EVLA ($n = 69$ limbs) for primary sapheno-femoral and GSV reflux. Varicose vein recurrence, ultrasound detected groin neovascularisation and patient satisfaction (visual analogue scale) were recorded.
Results: Recurrence rates at 2 years were: surgery group 4/60 (6.6%; mid-thigh perforator $n = 2$, residual GSV with neovascularisation $n = 2$), EVLA group 5/69 (7%; GSV recanalisation $n = 3$ (all received <50 J/cm laser energy), mid-thigh perforator $n = 1$, new anterior saphenous vein reflux $n = 1$) $p = 0.631$. Neovascularisation was detected in 11/60 (18%) of the surgery group and 1/69 (1%) of the EVLA group, $p = 0.001$. Patient satisfaction rates were 90% and 88% respectively ($p = 0.37$).
Conclusions: Although the frequency of recurrent varicosities 2 years after surgery and EVLA was similar, neovascularisation, a predictor of future recurrence, was less common following EVLA. Further, current recommendations on delivering ≥ 70 J/cm laser energy should reduce recanalisation rates and recurrence after EVLA.

* Corresponding author. Tel.: +44 0113 3922823; fax: +44 0113 3922624.
E-mail address: michael.gough@leedsth.nhs.uk (M.J. Gough).

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Introduction

Varicose vein recurrence is common following conventional great saphenous vein (GSV) surgery, occurring in 13–29% of patients.[1–3] About twenty percent of interventions for varicose veins are for recurrent varicosities after surgery.[4,5] Although the causes of recurrence include perforator incompetence, accessory vein reflux and inadequate primary surgery, groin neovascularisation is the commonest of these.[2]

Currently, there is increasing interest in the use of minimally invasive treatments for varicose veins, including foam sclerotherapy, radiofrequency and endovenous laser ablation. Critics of these techniques suggest that recurrence rates may be higher than that those for conventional surgery. The aim of the current prospective cohort study was to compare both recurrence and neovascularisation rates 2 years following either conventional surgical treatment or endovenous laser ablation (EVLA) for varicose veins.

Methods

Patients

The study was approved by our institutional ethics committee and informed written consent was obtained from patients. Consecutive patients undergoing treatment for primary varicose veins due to sapheno-femoral (SFJ) and great saphenous vein (GSV) reflux between January 2004 and May 2005 were suitable for either surgery or EVLA were included in this study, 68 of whom were enrolled in a randomised controlled trial comparing surgery with EVLA. The remainder declined randomisation but were treated contemporaneously and agreed to follow-up. Patients with a previous deep vein thrombosis, recurrent varicose veins, and those who had reflux in other axial veins (anterior accessory great saphenous vein, small saphenous vein) or perforators were excluded from the study.

Of 127 patients undergoing treatment, 118 (129 limbs, 72 female patients, 46 male, median age 48 [32–68]) have completed 2-year follow-up: conventional surgery (60 limbs) and EVLA (69 limbs).

Surgery

Surgical treatment was performed by a consultant vascular surgeon under general anaesthesia. A flush sapheno-femoral (SFJ) ligation was performed with ligation and division of all tributaries together with GSV stripping to the knee and multiple avulsions. No additional surgical strategies such as a groin patch or over-sewing of the saphenous trunk were used.

EVLA

EVLA was performed as described previously[6] (810 nm diode pulsed laser at 12 W power) by a consultant vascular surgeon or a research registrar. The GSV was ablated from the knee to the SFJ. Total laser energy (J) and energy density (J/cm) were recorded prospectively. At 6- and 12-weeks follow-up, residual superficial varicosities that were either visible or palpable and >3 mm in size were treated with foam sclerotherapy. Ultrasound guided foam sclerotherapy for persisting or recurrent GSV reflux was not performed during this study. The ''package'' of EVLA together with delayed sclerotherapy (when required) within 12 weeks of treatment achieves the same outcome as conventional surgery.

Data collection and follow-up

Pre-treatment clinical severity (CEAP) scores and treatment details were recorded prospectively. All patients underwent both clinical examination and a duplex ultrasound scan (DUS) using a TITAN® ultrasound system (Sonosite Inc., Bothell, USA) before treatment and at 6, 12, 52 and 104 weeks after the treatment. The maximum diameter of the GSV was measured using ultrasound (avoiding focal dilatations due to varicosities) while standing prior to the treatment. The reflux status of the SFJ, the treated GSV, the deep veins and all axial veins were documented in each visit. If visible, compressibility and detectable blood flow during calf squeeze and release of the treated GSV were also recorded at all follow-ups. Finally at 2 years patients were examined for evidence of recurrent varicose veins. This was defined as the presence of any visible or palpable varicosities measuring >3 mm on the treated leg that had been noticed by the patient or the examining clinician.

Neovascularisation (serpentine venous channels) in the groin was also identified by careful DUS assessment, with the probe held longitudinally, horizontally and at different angles. The largest diameter and the duration of reflux in these channels were documented. When present, neovascularisation was classified[7] as those of small size (<4 mm) with reflux of <1 s duration (Grade 1) and those with larger (≥ 4 mm) veins and prolonged reflux (>1 s; Grade 2). All recurrent varicosities were traced with DUS to identify the source of reflux including thigh or calf perforators. Patients' satisfaction scores at 2 years were obtained using a visual analogue scale.

Statistical analysis

Recurrence and neovascularisation rates were compared between groups using Fisher's exact test. Patients' satisfaction was compared using a Mann–Whitney *U* test. A p value of <0.05 was considered significant. All analysis were performed using the statistical package SPSS® for Windows (SPSS, Chicago, Illinois, USA).

Results

Patients' demographic details and pre-treatment disease severity are shown in Table 1. Recurrence and neovascularisation rates are compared in Table 2. At one year clinical recurrence was found in 2 surgical and 5 EVLA patients with groin neovascularisation present in 7 and 1 patients respectively.

At 2 years neovascularisation was detected in 11/60 (18%) patients following surgery and 1/69 (1%) after EVLA ($p = 0.001$). Of the patients with neovascularisation 6/11

Table 1 Base line characteristics of study patients

	Surgery	EVLA	*p*
Age: median (inter-quartile range, IQR)	46 (32—60)	49 (30—78)	0.43
Male: Female	39:21	45:22	0.49
Previous DVT	0	0	—
Pre-treatment C of CEAP[a]			
Number of limbs	64	73	
C2	39	43	0.42
C3	12	13	
C4	12	14	
C5/6	1	3	
GSV diameter (mm)[b] median (IQR)	7.8 (5.8—9.1)	8.1 (5.9—9.3)	0.24

[a] Pre-treatment C of CEAP classification (EAP of CEAP was the same in all patients — see exclusion criteria).
[b] Maximum diameter with patient standing, avoiding focal dilatations.

(55%) were Grade 1 and 5/11 (45%) Grade 2 in the surgery group whilst a single patient in the EVLA group had Grade 2 neovascularisation. Overall clinically apparent, cumulative recurrence rates up to 2 years were 4/60 (6.6%) and 5/69 (7%) following surgery and EVLA respectively ($p = 0.631$).

Following surgery, 2 patients developed recurrence due to an incompetent thigh perforator by 1 year and 2 were due to neovascularisation promoting reflux in a persisting, incompetent, segment of GSV (inadequate stripping) at 2 years. A further 9 patients showed evidence of groin neovascularisation on DUS but without clinical recurrence at 2 years.

All recurrences in the EVLA group were evident at one year with 3/5 (60%) following early GSV recanalisation by 12 weeks. These patients all received <50 J/cm laser energy during EVLA. Of these 3, one patient also had Grade 2 neovascularisation associated with GSV recanalisation. The remaining 2/5 (40%) recurrences were due to an incompetent mid-thigh perforator ($n = 1$), and reflux into the anterior accessory great saphenous vein (AAGSV, $n = 1$).

At 2 years, patients' satisfaction rates were 90% and 88% in the surgery and EVLA groups respectively ($p = 0.37$).

Two patients in the EVLA group had an active venous ulcer prior to the treatment. Two further patients (one from each group) had healed ulcers at the time of initial treatment. The active ulcers had healed by 12 weeks and by 6 months respectively and all remained healed at 2-year follow-up.

Table 2 Comparison of recurrence patterns and neovascularisation rates between groups treated by conventional surgery or EVLA

1-year follow-up (n = limbs)	Surgery ($n = 63$)	EVLA ($n = 71$)	*p*
Clinical recurrence	2/63 (3%)	5/71 (7%)	
Incompetent perforator	2 (3%)	1 (1%)	
Recanalisation/residual GSV	2 (3%)	3 (4%)	
Reflux into the AAGSV[a]	0 —	1 (1%)	
Neovascularisation	7/63 (11%)	1/71 (1%)	
2-years follow-up (n = limbs)	Surgery ($n = 60$)	EVLA ($n = 69$)	*p*
Clinical recurrence	4/60 (7%)	5/69 (7%)	0.44
Incompetent perforator	2 (3%)	1 (1%)	0.45
Recanalisation/residual GSV	2 (3%)	3 (4%)	0.36
Reflux into the AAGSV	0 —	1 (1%)	0.53
Neovascularisation	11/60 (18%)	1/69 (1%)	0.001

[a] AAGSV: anterior accessory great saphenous vein.

Discussion

Overall the recurrence rates for both conventional surgery and EVLA were similar 2 years after treatment. However, DUS detected groin neovascularisation was more common following surgery compared to EVLA. Thus, most recurrences following EVLA reflected inadequate primary treatment and it is likely that these could have been prevented by the administration of ≥70 J/cm laser energy to the vein.[6] The different patterns of recurrence following EVLA and surgery are depicted in Figs. 1 and 2.

Varying frequencies (8—60%)[7–12] of neovascularisation have been reported after surgery which probably reflects the differing duration of follow-up, surgical technique, and the sensitivity of DUS and the operator. Neovascularisation was detected in 18% (11/60) of limbs treated surgically in this series with 5/11 (45%) having Grade 2 neovascularisation which may be associated with a higher risk of recurrence. Although clinically obvious recurrence was not documented in most patients, Maeseneer et al.[7] have shown that neovascularisation rates at 1 year predict the development of clinical recurrence at 5 years. This reflects the likelihood that clinically obvious recurrence may take longer to develop, particularly in patients in whom the GSV has been adequately stripped, when secondary to neovascularisation.

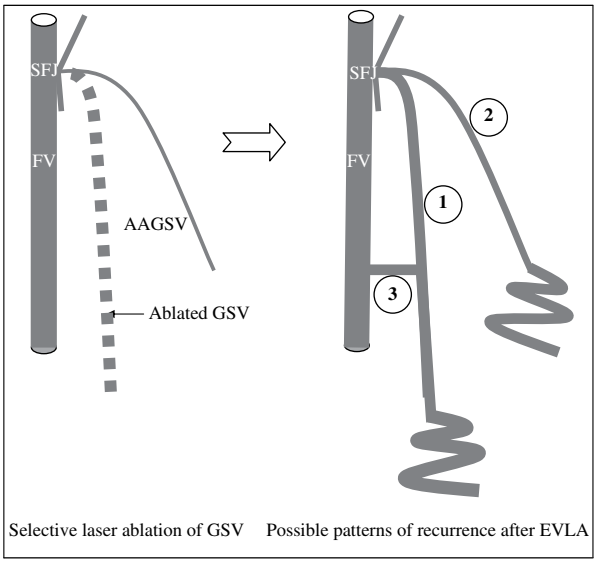

Figure 1 Possible patterns of reflux after EVLA (FV — femoral vein). 1: Recanalisation. 2: Neo-reflux into AAGSV. 3: Incompetent perforating vein.

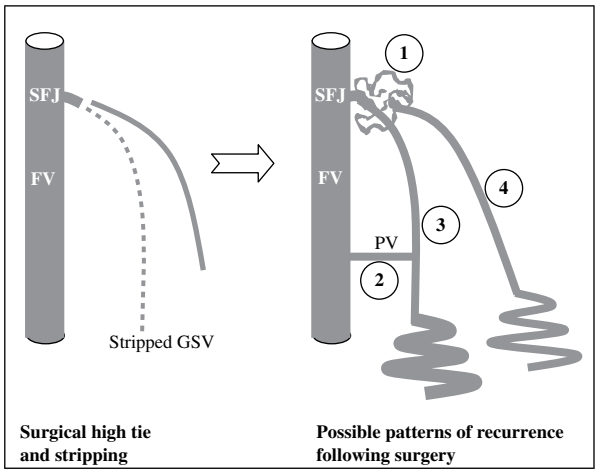

Figure 2 Patterns of reflux after surgery. 1: Neovascularisation. 2: Incompetent perforating vein. 3: Persisting GSV/new vessel formation. 4: Para-reflux connecting via neovascularisation.

Histological studies have suggested that neovascularisation is the result of angiogenesis following surgery[11] and modified techniques such as over-sewing the stump may reduce the risk of neovascularisation[12] although the use of a PTFE patch to separate the SFJ from the GSV tract did not prove successful.[13]

Since EVLA ablates the target vein within, extra-venous tissue injury is minimal and neovascularisation should not occur. However one patient in this series developed neovascularisation following laser therapy and it is logical to suggest that this was the result of vein wall perforation and haematoma formation. This advantage has also been reported following radiofrequency ablation[14] although there are no studies examining its frequency following DUS guided foam sclerotherapy.

Residual varicosities that persist after EVLA should be differentiated from recurrent varicose veins. The extent of residual varicosities depends on the pre-treatment anatomical distribution of varicosities and their haemodynamic relationship with the incompetent axial vein. Varicosities that are directly connected to the incompetent axial vein tend to shrink when this is ablated both below and above their origin. In contrast, varicosities that cross communicate with other ''feeding'' veins tend to remain as residual varicosities. A previous study has shown that ablation of the GSV from below the lowest point of axial vein reflux results in a 4-fold reduction in the requirement for delayed foam sclerotherapy (61—17%).[15]

Following ablation of a single incompetent axial vein, neo-reflux into another axial vein, is theoretically possible. This occurred in one patient who developed AASV reflux following GSV laser ablation. This could represent either neo-reflux or failure of pre-treatment DUS to demonstrate reflux into the ASV. The latter may be more likely since previous studies have shown that SFJ tributaries remain competent following selective EVLA of incompetent axial veins.[16,17]

Recanalisation occurs in up to 4% of axial veins after EVLA, although most are not associated with recurrent varicose veins unless it occurs within 6 weeks of treatment (primary treatment failure).[18] When recanalisation occurs early it is almost always associated with low energy densities (<60 J/cm). Given the current recommendation to employ ≥70 J/cm, it is anticipated that this type of recurrence will be uncommon in the future.[6]

A combination of neovascularisation and a residual segment of incompetent GSV led to recurrence in 2 patients in the surgery group reflecting the importance of ensuring that stripping is complete. Whilst this is not generally confirmed during surgery EVLA is performed under ultrasound control which should guarantee this. Although increasing sub-specialisation within general surgery should make inadequate surgery a less likely cause of recurrent varicose veins,[19,20] outcomes might be improved by employing DUS to confirm complete GSV stripping.

Incompetent perforating veins were a cause of recurrence following both operation and EVLA and may be the principle aetiological factor in up to 14% of patients with recurrent varicose veins following surgery.[21] This pattern of reflux may occur following neovascularisation within strip-tract haematoma or after incomplete stripping of the incompetent axial vein. It is therefore important that pre-treatment imaging identifies any perforators and that stripping or laser ablation is performed from the groin to a point distal to the perforating vein. In this respect, a potential advantage of EVLA is the ability to ablate an incompetent GSV beyond possible sites of perforating veins such as Boyd's perforators in the proximal calf without a significant risk of saphenous nerve injury[15] which commonly occurs following surgical stripping.

One criticism of this study is that it was of a prospective cohort design rather than an RCT although it did include patients from a previous randomised trial comparing EVLA and surgery[22] provided that they had attended for 2-year follow-up. In the randomised trial only 136 patients were successfully recruited after screening 534 patients (177 preferring a specific method of treatment (usually EVLA) and 221 not meeting the inclusion criteria). It was not considered practical to perform a second RCT to answer the important questions answered by the current study within a reasonable time frame.

In conclusion, different patterns of recurrence occur after EVLA and surgery. Although the overall recurrence rates for both techniques were similar at 2-year follow-up it is probable that recanalisation after laser ablation can be minimised by modifying laser energy delivery. In contrast neovascularisation is likely to remain a significant problem following conventional surgery although more widespread use of careful ultrasound assessment might ensure more successful stripping of the GSV and any associated incompetent axial veins. Nevertheless the very low incidence of neovascularisation following EVLA suggests that recurrence rates may be lower with this technique.

Conflict of Interest

None.

Funding

None.

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